(12) EUROPEAN PATENT APPLICATION

(72) Inventor: Hayashi, Katsuyoshi, c/o Kawagoe
Koujou

Pioneer Elec Corp
25-1 Aza Nishimachi
Ooaza Yamada
Kawagoe-shi, Saitama-ken(JP)
Inventor: Endo, Isao, c/o Kawagoe Koujou
Pioneer Elec Corp
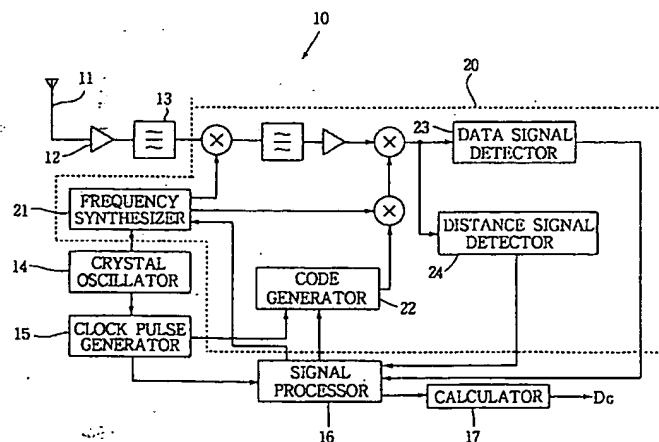25-1 Aza Nishimachi
Ooaza Yamada
Kawagoe-shi, Saitama-ken(JP)

(74) Representative: Sajda, Wolf E., Dipl.-Phys. et
al
MEISSNER, BOLTE & PARTNER
Postfach 86 06 24
D-81633 München (DE)

(54) **System for detecting an altitude of a vehicle dependent on a global positioning system.**

(57) When detecting altitudes the situation may arise where it is determined that an altitude (H) of a vehicle can not be calculated from data applied from satellites. When such a calculation can not be performed, a provisional altitude is obtained with the following equation:

$$H = (1 - \alpha) H_G + \alpha H_O$$

where H_G is an altitude obtained by the GPS, H_O is a reference altitude obtained by outside means, and α $(0 < \alpha < 1)$ is a predetermined smoothing coefficent.

EP 0 606 890 A1

FIG.1

On the other hand, B' is a point representing a GPS altitude $H_G(n-1)$ detected by the last four-satellite detection, and A' is a point representing a GPS altitude $H_G(n-2)$ at the time before last.

The altitude difference ΔH_0 between reference altitudes $Hp(n-1)$ and $Hp(n-2)$ points B and A is

$$\Delta H_0 = Hp(n-1) - Hp(n-2).$$

The altitude difference between GPS altitudes $H_G(n-1)$ and $H_G(n-2)$ is equal to the difference ΔH_C.

Therefore, the altitude H_{Gn} at the point C can be obtained as follows:

$$H_{Gn} = H_G(n-1) + \Delta H_0 .$$

Explaining the operation with reference to Fig. 8, when the three-satellite detection is performed (step 82), ΔH_0 is calculated at a step 83. The height H_{Gn} is calculated at a step 84, and the position is calculated at a step 85.

Referring to Fig. 9 showing the seventh embodiment, the embodiment is to obtain the height at the point B of Fig. 7. At a step 93, the position of the point A is calculated. The height $H_G(n-1)$ at the point B is calculated as a step 95.

The embodiment of Fig. 10 is the combination of the sixth embodiment of Fig. 8 and the fifth embodiment of Fig. 6.

The embodiment of Fig. 11 is the combination of the embodiment of Fig. 9 and the embodiment of Fig. 6.

While the presently preferred embodiments of the present invention have been shown and described, it is to be understood that these disclosures are for the purpose of illustration and that various changes and modifications may be made without departing from the scope of the invention.

Claims

1. A system for detecting an altitude (H) of a vehicle dependent on a global positioning system (GPS) comprising:
   determining means for determining that the altitude (H) can not be calculated from data received and applied from satellites (11, 12, 13) and for producing a provisional calculation demand;
   calculating means (15, 16, 17, 22) responsive to the provisional calculation demand for calculating a provisional altitude by correcting a GPS altitude obtained by the GPS at a last time and a reference altitude (H_0) obtained by outside means with a smoothing coefficient (α).

2. A system for detecting an altitude (H) of a vehicle dependent on a global positioning sys-

tem (GPS) comprising:
   determining means for determining that the altitude (H) can not be calculated from data received and applied from satellites (11, 12, 13) and for producing a provisional calculation demand;
   calculating means (15, 16, 17, 22) responsive to the provisional calculation demand for calculating a provisional altitude by adding a difference between reference altitudes (ΔH_0) obtained before to a GPS altitude obtained by the GPS.

3. The system according to claim 1 wherein:
   said outside means comprise a memory storing altitude data.

4. The system according to claim 1 or 3 wherein:
   said calculation is performed on the basis of the following equation:

   $$H = (1 - \alpha) H_G + \alpha H_0$$

   where H_G is an altitude obtained by the GPS, H_0 is a reference altitude obtained by the outside means, and α ($0 < \alpha < 1$) is a predetermined smoothing coefficient.